

A photograph of a forest with sunlight filtering through the trees. The sun is low in the sky, creating a warm, golden glow that illuminates the forest floor and the trunks of the trees. The trees are tall and slender, with some fallen logs on the ground. The overall atmosphere is peaceful and natural.

## Lesson 3

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# The Higher, the Fewer

**E**nergy is not transferred equally in an ecosystem and the amount of available energy varies at the level of consumption (primary, secondary, and tertiary consumers.) In Lesson 3, students learn about trophic levels (a step in the food chain or food web) and the organisms that are involved at the various levels of consumption.

An energy pyramid depicting levels of consumption introduces the concept of energy transfer.

Students participate in a scripted role-playing activity that demonstrates that while energy is passed through the ecosystem in food chains

and food webs, only about 10% is passed on to the next [trophic level](#). During this activity, some students read parts, other students use graph paper squares to represent the quantities of energy transferred at different trophic levels, and the rest of the class

serves as the audience. The activity builds a foundation for understanding that populations of organisms can be categorized by the functions they serve in an ecosystem.





## Learning Objective

Explain how energy is transferred in an ecosystem and how the amount of available energy varies at the level of consumption (primary, secondary, and tertiary consumers).



10% of the energy at each level is available to pass on to the next trophic level; 90% is used by the consumers themselves or lost to the environment as heat or waste products. Processes such as the contraction of muscles used in pumping blood, breathing, and moving use chemical energy from foods and give off heat. For example, warm-blooded animals such as mammals and birds use a lot of energy to maintain their body temperatures. Food waste contains undigested food that still has significant amounts of chemical energy in it.

Consumers at the top of an energy pyramid, as a group, have much fewer sources of energy available to them than those consumers closer to the bottom. Thus, in healthy ecosystems, there are relatively few top consumers. Eventually, the remaining amount of useful energy cannot support another level. That is why energy flow in an ecosystem is depicted in the shape of a pyramid. The energy that enters a community and moves up through the food chain is ultimately lost to the surroundings as heat.

## Background

When light from the sun reaches Earth, it is either reflected or absorbed. Some scientists estimate that plants and other producers (such as algae) absorb about 1% of incoming solar energy. **Producers** convert light energy into sugars and starches through the process of photosynthesis. Plants are the primary source of matter and energy entering most food chains, linking the survival of consumers with producers.

The steps in the food chain are sometimes referred to as trophic

levels (from the Greek root *trophi*, for food). The first **trophic level** consists of producers. Herbivores, or **primary consumers**, occupy the second trophic level. Animals that eat herbivores are secondary consumers and form the third trophic level. Animals that eat primary and **secondary consumers** are **tertiary consumers**, and so on up the food chain.

**Energy pyramids** are graphic models of energy flow in a ecosystem. The pyramid presents a picture of the amount of available energy that enters each trophic level. Only about

## Key Vocabulary

**Consumer:** Organism that obtains energy and materials by eating other organisms.

**Energy pyramid:** Graphic model showing that about 90% of the energy in organisms at a given trophic level is lost as the organisms are consumed by organisms at the next trophic level.

**Producer:** Organism such as a plant or alga that uses light energy or chemical energy to produce food (sugar) from inorganic chemicals.

**Primary consumer:** In a food chain, the first consumer; an herbivore.

**Secondary consumer:** The second consumer in a food chain; an organism that feeds on a primary consumer or herbivore.

**Tertiary consumer:** The third consumer in a food chain; an organism that feeds on a secondary consumer.

**Trophic level:** A step in a food chain or food web; producers are the first trophic level, herbivores the second, carnivores that feed on herbivores are the third, and so forth.

## Toolbox



### Summary of Activities

Students use energy pyramids and role-playing to learn about energy flow in a community. They start with 10,000 energy units, and as they read a script, they observe energy is lost at each trophic level in a food chain.



### Instructional Support

See Unit Resources, page 21

### Prerequisite Knowledge



- Students should know that energy entering ecosystems as sunlight is transferred by producers into chemical energy through photosynthesis and then from organism to organism through food chains and food webs.
- Students should also know that matter is transferred over time from one organism to others in the food web and between organisms and the physical environment.

### Advanced Preparation



#### Make copies:

Make copies as indicated in the Activity Masters section below. Also, make one copy per student of the **Mountain Lion Energy Pyramid** (Lesson 3 Visual Aid) transparency. (*optional*)

#### Highlight scripts:

Highlight individual actors' parts on their copies of **The Energy Transfer Story: The Higher, the Fewer** (Lesson 3 Activity Master).

#### Make energy units:

Cut apart one page of the **2000 Energy Units** (Lesson 3 Activity Master) as specified in Step 3 of the Procedure.

#### Create identification signs:

Make a sign identifying each of the six parts in the role-play. Glue each illustration provided in "Steps in the Energy Pyramid" onto a sheet of cardstock. Label each sign: narrator, sun, producer (grass), primary consumer (rabbit), secondary consumer (coyote), tertiary consumer (wolverine). Punch holes in the corners and attach string so students can wear the signs around their necks.



## Materials Needed



### Cardstock:

Six sheets

### String:

Six 3-foot lengths

### Activity masters:

See below

## Visual Aids



### Illustrations:

Steps in the Energy Pyramid,  
page 106 - 108

### Transparency:

Mountain Lion Energy Pyramid,  
page 109

## Duration



### Preparation time:

15-30 min.

### Instructional time:

45 min.



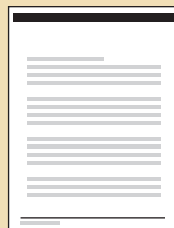
## Safety Notes

None

## Activity Masters



**The Energy Transfer Story:  
The Higher,  
the Fewer**  
Page 77  
Six per class



**2,000  
Energy Units**  
Page 79  
Six per class



**Energy Pyramid  
Assessment**  
Page 80  
One per student

# Procedures

## Step 1

Use the **Mountain Lion Energy Pyramid** (Lesson 3 Visual Aid) transparency to illustrate and discuss the various roles organisms play in an ecosystem and the loss of energy at each trophic level. Guide students in observing the titles of the levels on the pyramid (*producers, primary consumers, secondary consumers, tertiary consumers*) to emphasize that: (a) different organisms eat different foods (that is, have different energy sources), (b) at each trophic level there is less energy available, and (c) at each trophic level, there are fewer individual organisms. (*Note: The transparency also can be used as a student worksheet.*)

## Step 2

Write the following questions on the board. Review the questions with the class. Explain that students will be participating in a role-play. During the role-play, they should listen for clues that answer these questions.

- What happened to most of the energy that reached the plant? (*99% was reflected; only 1% was stored through photosynthesis*)
- In what form did the plants store energy? (As chemical energy in molecules such as glucose (*sugars*).)
- About what percentage of the energy taken in by the consumers was available for the next level of consumer? (*About 10%*)
- What happened to the energy that was not passed on to the next trophic level? (*Organisms used it for life processes such as moving, breathing, digesting, growing, capturing food, and finding shelter. Some was also lost with waste products.*)

## Step 3

Prepare students to participate in the energy transfer role-play. Select six students for reading parts and assign their roles. Give each reader the appropriate role sign and a highlighted script of **The Energy Transfer Story: The Higher, the Fewer** (Lesson 3 Activity Master). Select five students to represent the energy use. Pair one of these students with each of the readers, except the narrator, and give them prepared graph paper as follows:

- Narrator: no graph paper
- Sun: 5 full sheets of graph paper (10,000 energy units)
- Grass: 100 squares from graph paper (100 energy units)
- Rabbit: 10 squares from graph paper (10 energy units)
- Coyote: 1 square from graph paper (1 energy unit)
- Mountain lion: “mountain lion square” from graph paper (0.1 energy units)

Instruct participating students to line up in order at the front of the room holding their sign and energy units.



### Step 4

Ask the narrator to begin reading the script. Ask the other readers to read their parts when prompted; their partners should hold up their energy units as appropriate. Remind the rest of the class to listen attentively and be prepared to discuss energy transfer.

### Step 5

As time permits, pose the following reinforcing questions at appropriate points during or after the role-play:

- Plant: “Can anybody name other producers?” (Call on two or three students to name other plants such as pine trees, bushes, or oak trees.)
- Herbivore: “Can anybody name another first level or primary consumer?” (Call on two or three students to name other herbivores such as insects, deer, mice, and squirrels.)
- Second-level consumer: “Can anybody name another second level consumer or secondary consumer?” (Call on two or three students to name other carnivores such as mountain lions, snakes, hawks, and some insects.).

## Lesson Assessment

# Instructions

### Description:

The EEI Learning Objective for Lesson 3 requires students to explain how energy is transferred in an ecosystem and how the amount of available energy varies at the level of consumption (primary, secondary, and tertiary consumers). Students will demonstrate their learning using the **Energy Pyramid Assessment** (Lesson 3 Activity Master).

### Instructions:

#### For teacher:

Distribute the **Energy Pyramid Assessment** as a class quiz or homework.

### Suggested Scoring

#### Scoring Method:

The **Energy Pyramid Assessment** answer key is provided on page 43.



## Energy Pyramid Assessment (Lesson 3 Activity Master) | Answer Key

Use the Word Bank below to complete the sentences in Questions 1-7: (14 points)

### Word Bank

consumer	producer	tertiary consumer
energy pyramid	secondary consumer	trophic level
primary consumer		

1. An organism that obtains energy and materials by eating other organisms: consumer
2. Third consumer in a food chain; an organism that feeds on a secondary consumer: tertiary consumer
3. An organism such as a plant or alga that uses light energy or chemical energy to produce food (sugar) from inorganic chemicals: producer
4. The second consumer in a food chain; an organism that feeds on a primary consumer or herbivore: secondary consumer
5. A step in a food chain or food web; producers are the first level, herbivores the second, carnivores that feed on herbivores are the third, and so forth: trophic level
6. In a food chain, the first consumer; an herbivore: primary consumer
7. A model that shows that about 90% of the energy in organisms at a given trophic level is lost as the organisms are consumed by organisms at the next trophic level: energy pyramid
8. Draw the energy pyramid including: grass, rabbit, coyote, and mountain lion. Label each by their function: producers, primary, secondary, and tertiary consumers. And, label the three trophic levels; (6 points)  
*The pyramid should have four levels—the base should show the grass and have it labeled as a producer; the next level up should have rabbits and the rabbits should be labeled as primary consumers; the next level up should show a few coyotes and the coyotes should be labeled as secondary consumers; and the top of the pyramid should have a single mountain lion labeled as the tertiary consumer.*
9. Answer the following question on the bottom of the page on which you draw the pyramid: About what percentage of the energy taken in by each of the consumers is available for the next level of consumers? (5 points)  
*About 10%*